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Bacterial Septic Peritonitis

P Profile

Definition

- Septic peritonitis is an infection of the peritoneal cavity with a pathogenic organism (bacterial, fungal, viral, or protozoal).
- *Primary* septic peritonitis, caused by a spontaneous (hematogenous or lymphatic) source of infection, is rare and usually involves a monomicrobial infection. Such infections can also be caused by device-associated infection (eg, peritoneal catheters).
- *Secondary* septic peritonitis is caused by intraabdominal pathologic abnormalities (eg, intestinal perforation) and is usually polymicrobial (**Table**).
- Feline infectious peritonitis is a syndrome initiated by feline coronavirus; however, it is considered a sterile, nonseptic peritonitis caused by a severe inflammatory and immune-mediated response induced by viremia.

Risk Factors

- Recent abdominal surgery
- Foreign body ingestion
- Trauma (eg, gunshot or other penetrating abdominal trauma, bite wound, vehicular trauma, blunt trauma)
- Administration of nonsteroidal or steroidal antiinflammatory agents
- Intact male or female (history of recent heat cycle or whelping/queening)
- Intraperitoneal chemotherapy
- Peritoneal catheter placement

Pathophysiology

- Bacteria most commonly associated with septic peritonitis include *Escherichia coli*, *Clostridium* species, and *Enterococcus* species.
- The peritoneal cavity becomes infected with a pathogenic organism via translocation, penetrating wound, or leakage from the gastrointestinal tract (most common cause) or an infected organ.
- Once pathogens come in contact with inflammatory cells, the production of cytokines and vasoactive substances results in septic peritonitis. This can progress to a systemic inflammatory response that causes vasodilation, extravasation of albumin and plasma water, pain, and hypovolemia. Vomiting, decreased water intake, and fever also contribute to total-body water loss.
- The resulting hypovolemic and vasodilatory shock can lead to reduction in splanchnic blood flow, disseminated intravascular coagulation, and multiple organ dysfunction syndrome.
- Hypoglycemia induced by sepsis can result in profound weakness, cardiovascular dysfunction, and such neurologic signs as ataxia, seizures, stupor, or coma.

Signs

History

- Recent abdominal surgery
- Foreign body ingestion
- Vomiting, diarrhea, and loss of appetite
- Lethargy
- Abdominal pain

Causes of Secondary Septic Peritonitis

Gastrointestinal tract

- Perforating foreign body
- Mass rupture
- Ulcer perforation
- Ischemia
- Surgical wound dehiscence or leakage
- Translocation through inflamed intestinal wall
- Pancreatic abscess

Genitourinary tract

- Urinary tract rupture with existing infection
- Uterine rupture
- Pyometra
- Prostatic abscess
- Renal abscess

Hepatobiliary leakage with existing infection

- Necrotizing cholecystitis
- Biliary mucocele
- Liver lobe torsion
- Hepatic abscess

Other

- Penetrating abdominal wall trauma
- Evisceration
- Surgical contamination
- Splenic or lymphatic abscess
- Peritoneal dialysis

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Physical Examination

- Signs of poor perfusion related to shock:
 - *Compensatory*: Dogs—tachycardia, red mucous membranes, rapid CRT
 - *Decompensatory*: Dogs—tachycardia, pale mucous membranes, prolonged CRT; cats—bradycardia, hypothermia, pale mucous membranes, prolonged CRT
- Weak or hyperdynamic pulse quality
- Abdominal pain (however, about 50% of cats with septic peritonitis reportedly do not show signs of abdominal pain)
- Fever or hypothermia
- Abdominal distention (may not be present)
- Depressed mentation

Pain Index

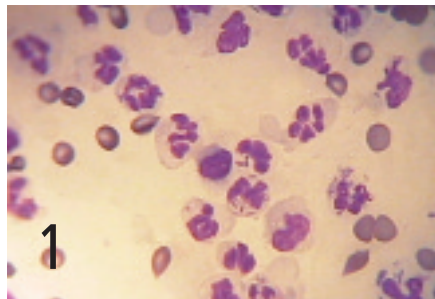
Pain associated with septic peritonitis is usually moderate to high.

Dx Diagnosis

Definitive Diagnosis

- Abdominal fluid analysis, including cytologic assessment and aerobic, anaerobic, and fungal cultures, is required. Fluid is most easily collected by using ultrasonographic guidance.
- Blind abdominocentesis or diagnostic peritoneal lavage can also be used to collect a sample of abdominal fluid. However, results of a blind abdominocentesis may be negative if < 5 mL/kg of peritoneal fluid is present.
- Peritonitis is indicted when abdominal fluid contains a high number of neutrophils. Presence of pathogens typically makes neutrophils appear degenerative or toxic.
- Definitive diagnosis of septic peritonitis is made when pathogens are observed. Intracellular or extracellular bacteria may be seen on cytologic examination (**Figure 1**) or when bacterial or fungal cultures grow pathogens.

CRT = capillary refill time



Diff-Quik (diagnostics.siemens.com) stain of abdominal fluid from a dog with a perforated jejunum caused by an intestinal foreign body obstruction. The neutrophils are degenerative and toxic, and a mixed population of rod-shaped and round pathogens is seen in the cytoplasm of many neutrophils.

- If cultures are needed to definitely diagnose septic peritonitis, immediate exploratory surgery may still be warranted; waiting for culture results carries more risk for illness and death than “negative” exploratory surgery.

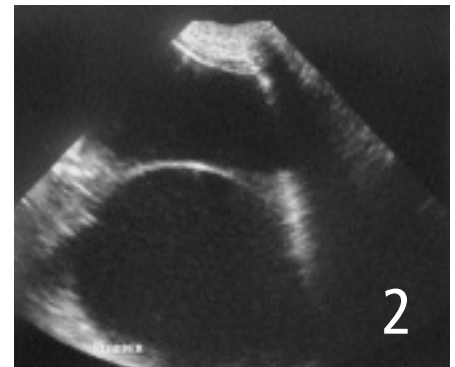
Differential Diagnosis

A modified transudate or exudate that is not caused by infection may indicate:

- Right-heart failure
- Hepatic failure
- Hemoabdomen
- Leakage of gastric contents (gastric perforation or leakage from previous gastrotomy)
- Pancreatitis
- Ischemia/necrosis of abdominal organ
- Nonseptic uroabdomen or hepatobiliary rupture.

Laboratory Findings & Imaging

- Supportive laboratory findings of a septic peritonitis include:
 - Leukocytosis or leukopenia
 - Left shift
 - Hypoglycemia
 - Abdominal glucose level > 20 mg/dL lower than blood glucose level (dogs)
 - Peritoneal fluid lactate level > 2.5 mmol/L or a difference < -2 mmol/L

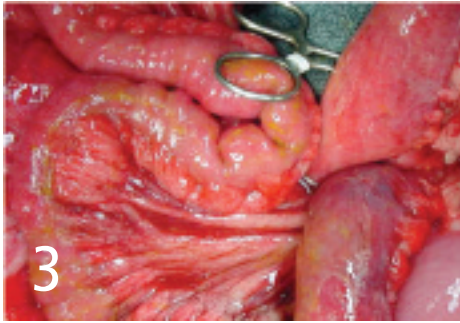


Ultrasonographic findings indicating abdominal effusion. Septic peritonitis typically results in abdominal fluid that has a complex echogenic appearance.

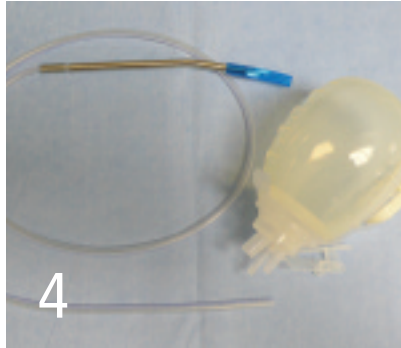
- between lactate levels in blood and peritoneal fluid (dogs)
- Survey abdominal radiographs may show loss of visceral detail, an obstructive gas pattern in the bowel, foreign bodies, or pneumoperitoneum.
- Ultrasonographic findings include the presence of abdominal fluid that may appear complex (**Figure 2**). Other organ abnormalities may be seen depending on the cause of the peritonitis.
- When abdominal fluid bilirubin level exceeds the serum bilirubin level, a hepatobiliary tract rupture should be suspected.
- When the abdominal fluid creatinine or potassium level exceeds the serum creatinine or potassium level, a urinary tract rupture should be suspected. Contrast urography may confirm a rupture, although urinary tract leaks can seal over and result in negative findings.

Postmortem Findings

The abdominal cavity usually contains a large volume of cloudy fluid that is gray, creamy, or red. It may contain flocculent material (**Figure 3**). The amount of accumulated exudate varies widely; it may spread to the whole peritoneum, or be walled off by the omentum and viscera. The serosal sur-



Typical findings of septic peritonitis. The intestinal tract is hyperemic, and there is a fibrinous lining that can be peeled away from the serosa. There is petechiation of the mesentery and the serosal and visceral lining. The fluid is red and cloudy.



Bulb drain and fenestrated tube of a Jackson-Pratt drain. Once the drain is connected to the tube, negative pressure is maintained by compressing the bulb and closing the cap.

faces may adhere to each other, and it is not uncommon to find the omentum adhered to the infected organ. The peritoneal lining and visceral organ surfaces may have petechiae or ecchymotic lesions, and the peritoneal lining may be dull rather than glistening.

Tx Treatment

Inpatient treatment is the only option for bacterial septic peritonitis. Clinical signs of peritonitis warrant rapid fluid resuscitation, analgesia, and rehydration.

Surgery & Lavage

- Surgical repair and removal of infected tissue, as well as copious lavage and suction, are required for definitive treatment.
- With severe infections, in which ongoing effusion is likely, postoperative abdominal drainage is recommended. Closed abdominal drainage (using active suction drains [eg, Jackson-Pratt drain; cardinal.com] attached to an external reservoir that creates negative pressure) is preferred over open abdominal drainage because it is less labor intensive and more easily managed, allows quantification of accumulated fluid, and permits repeated fluid analysis (Figure 4).

- Some surgeons may prefer large-volume lavage (at least 300 mL/kg) and suction before closure of less severe infections, when source of contamination is definitively repaired.
- Postoperative lavage cultures provide information on the effectiveness of intraoperative lavage in eliminating infection. In some cases, the exploratory procedure may have to be repeated to reexamine damaged tissue.
- If immediate surgery is not possible, a peritoneal lavage catheter can be placed to allow infusion of sterile saline or lactated Ringer's solution to dilute and drain infected contents. Body-temperature sterile saline (10–20 mL/kg) is infused, the abdomen is gently agitated, and the fluid is drained by using passive drainage into a sterile closed-collection system. This process is repeated until the appearance of the fluid clears.

Nutrition Parenteral

Partial parenteral nutrition, infused through a peripheral or central venous catheter, can be provided immediately upon diagnosis and used as the maintenance fluid infusion. Additional balanced isotonic crystalloids are used to replace ongoing losses.

Enteral

- Enteral nutrition using temporary feeding tubes is provided during postsurgical recovery. Immediate enteral feeding may reduce the risk for bacterial translocation and ulceration, and augment mucosal healing in cases of gastrointestinal surgery.
- Feeding begins with one third daily caloric needs. Over 48 to 72 hours, intake is increased to full caloric needs.
- Because it may take several days for gastric function to return, intermittent gastric tube suction may be needed to reduce vomiting.
- Metoclopramide (1–2 mg/kg Q 24 H after a single intravenous dose) and cisapride (0.5–1 mg/kg PO Q 8 H) may promote gastric emptying. In addition, intravenous lidocaine at analgesic doses (see **Septic Peritonitis: Analgesic Medications**, page 46) may improve gastrointestinal motility in cases of postoperative ileus.
- Bypassing the stomach and feeding through nasojejunal or jejunostomy tubes can permit enteral feeding until gastric function is restored.
- Experience is needed to properly place gastrostomy or jejunostomy feeding tubes. Placement of nasogastric, nasojejunal, or esophageal tubes requires less experience, and these tubes do not necessitate surgery if they become prematurely removed.

Length of Care

At least 3 to 5 days of hospitalization is often necessary when treating septic peritonitis. Reexploration may be necessary in some cases, and owners should be told of this possibility at the time of the initial surgery.

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Medications

Fluids

Loss of proteins and large volumes of plasma water into the abdomen and gastrointestinal tract is common.

- Initial fluid resuscitation should include balanced isotonic crystalloids and synthetic colloid (hetastarch) administration. See the **Management Tree**, page 61, for an approach to treating hypovolemic shock.
- After correction of the underlying cause, restoration of normal fluid balance takes 2 to 5 days. Because albumin becomes an ineffective colloid in patients with systemic inflammatory response syndrome, use of hetastarch, which contains large heavy-weight colloid molecules, permits maintenance of intravascular colloid osmotic pressure and reduces loss of intravascular fluid into the peritoneal cavity.
- The volume of plasma transfusions required to restore plasma albumin levels in the patient with septic peritonitis makes this therapy costly, increases patient risk for fluid overload, and drains transfusion product reserves.
- Use of human albumin concentrate to replace albumin is controversial in septic veterinary patients due to the risk for acute and delayed hypersensitivity reactions in dogs. Although there is a theoretical benefit to maintaining albumin homeostasis, no controlled studies have evaluated the benefit of maintaining plasma albumin levels in septic peritonitis cases.
- Frozen or fresh frozen plasma may be necessary when coagulation factor deficiencies result in bleeding tendencies.

Analgesia

- Pure agonist opioids can be used intravenously. Intravenous benzodiazepines, low-dose ketamine, and lidocaine can augment opioid analgesia. Continuous

intravenous infusion after a bolus injection provides continuous analgesia that can be modified according to patient needs.

- The greatest relief may be obtained with epidural analgesia using morphine with or without local anesthetics. Longer-term analgesia can be administered by using an epidural catheter.
- Nonsteroidal antiinflammatory analgesics are not administered until gastrointestinal integrity and renal function are determined to be normal and hypotension is not considered a concern. Alpha-2 agonists are avoided until cardiovascular stability is ensured.

Antibiotics

- Once culture samples have been obtained, broad-spectrum IV antibiotics are provided for common enteric pathogens such as gram-negative and anaerobic bacteria. Examples include ampicillin–sulbactam with metronidazole, or first-generation cephalosporins with aminoglycoside and metronidazole. Second- and third-generation cephalosporins and fluoroquinolones are reserved for documented resistant infections.
- Aminoglycosides are used with close monitoring of renal function. Amikacin (15 mg/kg IV Q 24 H) may be preferred over gentamycin in renal-compromised cases. Daily examination of the urine for casts, glucose, and protein can reveal renal tubular injury. In addition, daily comparison of the urine gamma-glutamyl transferase:creatinine ratio with baseline values may uncover early renal toxicity in the dog. Maintaining hydration and renal perfusion will reduce risk for toxicity.



Follow-Up

Monitoring

Postoperative monitoring should include evaluation of **Kirby's Rule of 20** (page 42). These are clinical variables that must be

addressed in the critical patient once or twice daily to maximize recovery and minimize complications by anticipating alterations in organ function.

Complications

Complications can include adhesion formation, dehiscence, and persistent or secondary infection.

Prognosis & Home Care

A favorable prognosis is expected when the patient is eating and drinking without vomiting, afebrile, and comfortable 2 to 5 days after surgery. At-home treatment generally consists of analgesia and a bland diet for the week after discharge, and antibiotics until final culture results are documented. Patients are occasionally discharged with feeding tubes until they are voluntarily eating adequate amounts of food.

Future Follow-Up

Further follow-up is usually needed only for removal of feeding tubes and sutures.



In General

Septic peritonitis requires major abdominal surgery and intensive care (\$\$\$\$\$). Survival rates are reported to be about 70% for bacterial peritonitis in dogs and cats regardless of the method of drainage, and 54% for cases that are lavaged and closed without drainage. Prognosis is good when early surgical intervention is provided and septic shock avoided. ■

Cost Key

\$ = < \$100	\$\$\$\$ = \$500–\$1000
\$\$ = \$100–\$250	\$\$\$\$\$ = > \$1000
\$\$\$ = \$250–\$500	

See **Aids & Resources**, back page, for references, contacts, and appendices. Article archived on cliniciansbrief.com

Septic Peritonitis: Analgesic Medications for Dogs & Cats

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Analgesic	Canine Dose	Feline Dose	Frequency
Opioids			
Buprenorphine		0.005–0.01 mg/kg <i>SC, IM, IV, PO</i>	Q 6–8 H
Morphine	0.5–2 mg/kg <i>SC, IM</i>	0.05–0.2 mg/kg <i>SC, IM</i>	Q 3–4 H
	0.5–1 mg/kg <i>IV slow</i>	0.1–0.4 mg/kg <i>IV slow</i>	Q 3–4 H
	0.1–0.3 mg/kg/H <i>CRI</i> (after 0.5 mg/kg <i>IV slow</i>)	0.1–0.3 mg/kg/H <i>CRI</i> (after 0.25 mg/kg <i>IV slow</i>)	
	0.1–0.3 mg/kg <i>EPI</i> ; preservative-free	0.1 mg/kg <i>EPI</i> ; preservative-free	Q 12–24 H
Oxymorphone	0.05–0.2 mg/kg <i>SC, IM, IV</i>	0.05–0.1 mg/kg <i>SC, IM, IV</i>	Q 2–4 H
	0.05–0.2 mg/kg <i>EPI</i>	0.05–0.1 mg/kg <i>EPI</i>	Q 8 H
Hydromorphone	0.1–0.2 mg/kg <i>SC, IM, IV</i>	0.02–0.1 mg/kg <i>SC, IM, IV</i>	Q 2–6 H
Fentanyl	<i>Patch</i> 25 mcg < 10 kg 50 mcg 10–20 kg 75 mcg 20–30 kg 100 mcg > 30 kg	<i>Patch</i> 25 mcg	Q 3–4 days (onset of effect 12–24 H after application)
	3–6 mcg/kg/H <i>CRI</i> (after 5 mcg/kg bolus)	1–5 mcg/kg/H <i>CRI</i> (after 3 mcg/kg bolus)	
Nerve Blocks			
Lidocaine	< 12 mg/kg <i>local</i> 3–5 mg/kg (6 mL total) <i>EPI</i>	< 6 mg/kg <i>local</i> 3–5 mg/kg (1.5 mL total) <i>EPI</i>	Mix with opioid <i>EPI</i>
Bupivacaine	< 2 mg/kg <i>local</i> 1.5–2.5 mg/kg (6 mL total) <i>EPI</i>	< 2 mg/kg <i>local</i> 1.5–2.5 mg/kg (1.5 mL total) <i>EPI</i>	Mix with opioid <i>EPI</i>
Muscle Relaxants			
Diazepam	0.2–0.6 mg/kg <i>IV</i>	0.5–1 mg/kg <i>IV</i>	Mix with opioid
Midazolam	0.1–0.2 mg/kg <i>IV</i>	0.1–0.2 g/kg <i>IV</i>	Mix with opioid
Combination			
Morphine	10 mg in 500 mL		<i>CRI</i> at calculated maintenance fluid rate; increase rate/dose as needed
Lidocaine	150 mg in 500 mL		
Ketamine	30 mg in 500 mL		

CRI = constant rate infusion; EPI = epidural; IM = intramuscular; IV = intravenous; SC = subcutaneous

Kirby's Rule of 20 for Monitoring the Critical Patient

- | | | |
|-----------------------------|-----------------------------------------|---------------------------------|
| 1 Albumin | 8 Gastrointestinal motility & integrity | 14 Nutrition |
| 2 Blood pressure | 9 Glucose | 15 Oxygenation/ventilation |
| 3 Coagulation | 10 Heart rate, rhythm, & contractility | 16 Pain control |
| 4 Colloid osmotic pressure | 11 Immune status, antibiotics | 17 Red blood cells & hemoglobin |
| 5 Drug dosages & metabolism | 12 Mentation | 18 Renal function |
| 6 Electrolytes | 13 Nursing care | 19 Tender loving care |
| 7 Fluid balance | | 20 Wound care & bandages |

Data obtained from Systemic inflammatory response syndrome: Septic shock. Purvis D, Kirby R. *Vet Clin North Am Small Anim Pract* 24:1223, 1994.

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